

# Is energy density associated with type 2 diabetes in adults?

## Conclusion

Consistent but limited evidence suggests that lower-energy density diets may be associated with lower risk of type 2 diabetes among adults.

## Grade: Limited

Overall strength of the available supporting evidence: Strong; Moderate; Limited; Expert Opinion Only; Grade not assignable For additional information regarding how to interpret grades, [click here](#).

## Evidence Summary Overview

### Energy Density and Type 2 Diabetes

Two longitudinal cohort studies have examined the association between energy density and the risk of type 2 diabetes (T2D). One cross-sectional study examined the association between energy density and risk factors for T2D, including hyperinsulinemia and metabolic syndrome. All three studies found a relationship between energy density and increased risk for T2D or having risk factors for T2D. Two European cohort studies, one conducted in the United Kingdom (Wang, 2008) and one in Finland (Lindstrom, 2006), with follow-up periods lasting for 10 years and three years, respectively, found a relationship between energy density and T2D. Whereas the United Kingdom study was observational, the Finnish study was designed as a randomized controlled trial (RCT) although reported findings were based on pooled analyses. When expressed as energy density quartiles, the Finnish study results did not reach statistical significance even though effect size was strong (70% increased risk), a finding likely explained by the lack of statistical power. Findings from this study were, however, statistically significant when dietary intake patterns were modeled based on their energy and fiber content. T2D was either diagnosed through plasma biomarkers (Lindstrom, 2006) or a participant self-report confirmed with medical records (Wang, 2008). Both studies controlled statistical analyses for relevant anthropometric measures (weight, BMI, weight change or waist circumference) and the United Kingdom study adjusted for energy intake as well. Thus, findings suggest that diet composition, independent of energy balance may play a role on potential association between energy density and T2D. This conclusion is consistent with 1999-2002 NHANES cross-sectional findings (Mendoza, 2007) documenting an association of energy density with elevated fasting insulin, after controlling for waist circumference and physical activity.

### Evidence summary paragraphs:


#### *Prospective Cohort Studies (2)*

**Lindstrom et al, 2006** (positive quality) analyzed prospective cohort data from a RCT in Finland to assess the association between dietary fat, fiber and energy density and change in body weight, waist circumference and diabetes risk. Subjects were participants in the Finnish Diabetes Prevention Study (DPS). Middle-aged men and women with impaired glucose tolerance were randomly assigned to either standard care or intensive dietary and exercise counseling. Baseline and annual follow-up examinations included three-day diet records and diabetes status by repeated 75g OGTTs. Energy density was calculated by dividing energy of food consumed by food weight (100g). The

final sample included 500 subjects (mean age 55 years, mean BMI, 31kg/m<sup>2</sup>). After a mean follow-up of 4.1 years, 114 of the 500 participants had been diagnosed with diabetes. Those in the lowest quartile of energy density had a lower risk of developing type 2 diabetes compared to the highest quartile of energy density (HR 1.74;95% CI 0.89-3.37), though this difference did not reach statistical significance.

**Wang et al, 2008** (neutral quality) analyzed prospective cohort data from the United Kingdom to investigate the association of dietary energy density with new-onset diabetes. Subjects were participants in the European Prospective Investigation of Cancer (EPIC)-Norfolk Study. Energy density was calculated for overall diet, foods and beverages combined. The final sample included in 21,919 subjects (mean age, 58 years). During a median follow-up of 10.2 years (range 7.6-12.8 years), 725 new-onset cases of T2D were documented. Baseline energy density was higher in those who developed T2D than in those who remained non-diabetic (mean 3.08kJ per gram, P=0.012). After adjustment for known risk factors, energy density was positively associated with incident diabetes (odds ratio 1.21 per unit increase [95% CI: 1.06-1.38]). In adjusted analyses, there was a 60% higher risk of diabetes in the highest quintile of energy density (range 3.55-7.97kJ per gram) compared with the lowest quintile (1.04-2.43kJ per gram). The authors concluded that an energy-dense diet may be associated with increased risk of developing diabetes, independent of baseline obesity.


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Author, Year, Study Design, Class, Rating	Populations/Subjects	Methods	Outcomes
Wang J, Luben R et al, 2008  Study Design: Prospective Cohort Study  Class: B  Rating: 	N= 21,919 (mean age, 58 years).  Location: Europe.	Energy density was calculated for overall diet, foods and beverages combined.  Mean follow-up was 10.2 years.	Baseline energy density was higher in those who developed T2D than in those who remained non-diabetic (mean 3.08kJ/g, P=0.012).  After adjustment for known risk factors, energy density was positively associated with incident diabetes (OR 1.21 per unit ↑ [95% CI: 1.06- 1.38]).

### Research Design and Implementation Rating Summary

For a summary of the Research Design and Implementation Rating results, [click here](#).

### Worksheets

 [Lindström J, Peltonen M, Eriksson JG, Louheranta A, Fogelholm M, Uusitupa M, Tuomilehto J. High-fibre, low-fat diet predicts long-term weight loss and decreased type 2 diabetes risk: the Finnish Diabetes Prevention Study. \*Diabetologia\*. 2006;49\(5\):912-20.](#)

 [Wang J, Luben R, Khaw KT, Bingham S, Wareham NJ, Forouhi NG. Dietary energy density predicts the risk of incident type 2 diabetes: the European Prospective Investigation of Cancer \(EPIC\)-Norfolk Study. \*Diabetes Care\*. 2008 Nov; 31 \(11\): 2,120-2,125. Epub 2008 Aug 8.](#)